# Developing a predictive empirical model to optimize biomaterials characteristics for intra-oral bone regeneration

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## INTRODUCTION

Facial trauma, bone resection due to cancer, periodontal diseases and bone atrophy following tooth extraction often lead to alveolar bone defects that requires bone regeneration in order to restore dental function. Guided bone regeneration using allogenic, xenogenic or synthetic biomaterials has been promoted as an alternative approach to autologous bone grafts. Efficiency of bone grafts is influenced by their physico-chemical characteristics; however, the debate is still ongoing on what constitutes these optimal bone substitute material characteristics. The purpose of this study was to develop a predictive empirical model allowing to assess the bone regeneration potential of new biomaterials on the basis of their physico-chemical characteristics, potentially giving directions of the design of a new generation of dental biomaterials.

## METHODS

A quantitative data set was built composed of morphological characteristics of 7 commercially available intra-oral bone biomaterials (BioOss®, BioOss®-Collagen, BoneCeramic®, Cerasorb®, MP3®, Natix® and Ostim®) and their *in vivo* response when implanted in a sinus augmentation model in rabbits[1-3]. The morphological properties include chemical composition, micro-porosity and surface roughness parameters. To acquire the surface profile of bone grafts for surface roughness evaluation, we used an in-house developed protocol that allows non-destructive assessment of the micro-scale roughness of porous materials at the outer surface when it is applied on high-resolution SEM images[4]. A partial least square regression (PLSR) model was applied to the data set in order to gain find out which (combination of) morphological characteristics would allow to predict the bone regenerative response after in vivo implantation, quantified by the bone to material contact that was evaluated from histology at 3 time points.

## RESULTS AND DISCUSSION

The empirical model based on the aforementioned data set, allowed identification of the construct parameters driving optimized bone formation i.e. (a) the percentage of chemical components, (b) micro-porosity and (c) surface roughness. A leave-one-out strategy was employed to avoid overfitting and assess the potential of the empirical model to be applied to other new materials not present in the training data set.

## CONCLUSION

The presented model provides a better understanding on the influence of driving biomaterial properties in the bone healing process as well as a robust tool for the design of (3D printable) bone biomaterials with more controlled and custom-made structure. This method appears to facilitate and improve clinical translation.

## REFERENCES


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## KEYWORDS

Guided bone regeneration, alveolar graft, empirical modeling, micro-porosity and surface roughness.